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Changes in vegetation and fuel use from the Neolithic to the Middle Ages in the western Catalan plain

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***Summary**: This paper presents a synthesis of charcoal analysis data from the West Catalan plain, from the Neolithic to Medieval times. We discuss the changes and trends in the consumption of firewood. Collecting firewood was carried out in an environment characterized by open vegetation, which appears to have been dominating in the area since the Bronze Age. In this environment* Pinus halepensis *has played a fundamental role. On the other hand one can observe a progressive extension of the firewood catchment areas in more recent periods, especially in Roman and medieval times.*

***Key words**: western Catalan plain, forest exploitation, historical vegetation, anthracological synthesis, human activity.*

INTRODUCTION

The western Catalan plain is located in the northeastern Iberian Peninsula. Geologically, it is part of the great morpho-structural unit of the Ebro Basin. Physiographically, this plain corresponds to the sicor territory and it is crisscrossed by Rivers Cinca and Segre and their tributaries. This plain has been a densely populated territory since prehistoric times. The exploitation of forest resources in recent millennia has caused important modifications of the vegetation and the landscape. To characterize this exploitation since the beginning of agricultural production is of great importance in order to infer the relationship of the people who inhabited the plain with their environment.

The forest history is the result of environmental variables but also of the interaction between people and their environment. The main objective in this study is to assess the evolution of the forests of the western plain in relation to human societies.

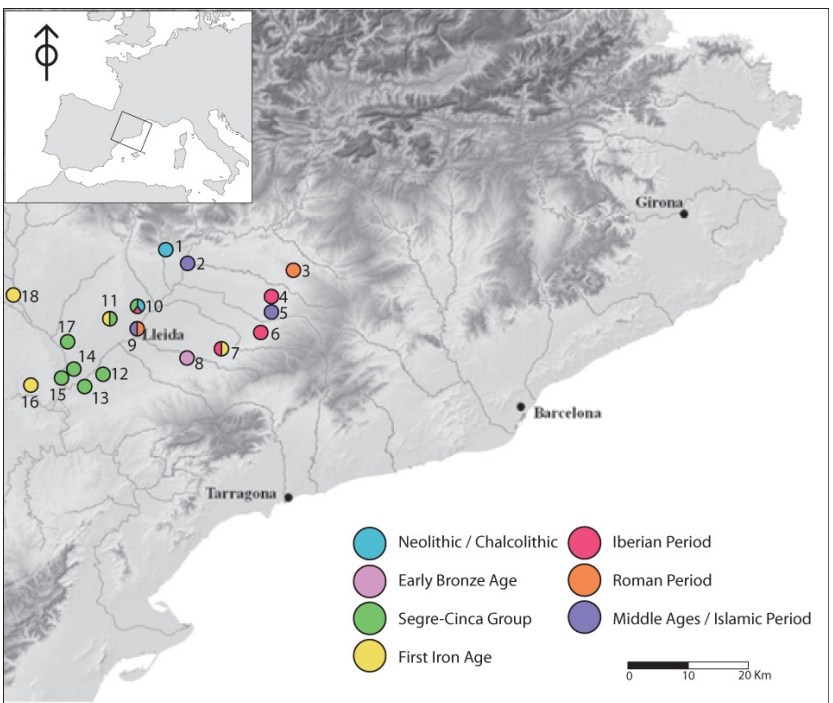
Although there are diverse disciplines that provide important information on this issue, in this case we focus on the study of carbonized wood remains, as they represent the resources of the different environments which were exploited by past societies. Charcoal studies from the area, which have a long tradition, started

in 1988. To date, materials from 18 archaeological sites (Fig. 1) of various periods and regions have been analyzed by several specialists, starting with Maria Teresa Ros (1993, 1994-1996, 1995a, 1995b, 1995c), followed by Raquel Piqué and collaborators (Piqué 1998a and b, 2003, 2006, 2008, unpublished a and b; Piqué and Noguera 2000; Piqué and Mensua 2001; Alonso *et al*. 2002; Buxó *et al*. 2004; Martín-Seijo and Piqué 2008; Martín-Seijo and Piqué 2009; Piqué and Vila 2010) and Ethel Allué and Itxaso Euba (2005). However, such studies did not follow a predetermined order within the framework of a specific project.

The reason for the present study is the lack of a synthesis that encompasses all these wood charcoal analyses results and offers the evolution of the landscape in the plain from the Neolithic until the Middle Ages.

DATA AND RESULTS

Published and unpublished data from all these previous studies were collected (Vila 2010). This is a considerable volume of remains, with a total of 14,774 charcoal fragments. Of these, 12,858 fragments from 502 samples have been determined taxonomically (Tables 1 to 6). However, several problems exist in order to make a regional synthesis from anthracological data and interpret the results in a palaeoenvironmental sense. On the one hand, we should keep in mind that the social activity that generated the charcoals and the postdepositional processes are specific to each site. These factors may be partly responsible for the variability, especially in quantitative terms (Piqué 1998c: 7). On the other hand, the differences in the size of the analyzed samples for each site and the methods of recovery of the remains may have also influenced



1. Auvelles (Castelló de Farfanya, La Noguera); 2. Pla d'Almatà (Balaguer, La Noguera); 3. Iesso (Guissona, La Segarra); 4. Missatges (Tàrrega, l'Urgell); 5. Molí del Codina (Tàrrega, l'Urgell); 6. Estinclells (Verdú, l'Urgell); 7. Els Vilars (Arbeca, les Garrigues); 8. Minferri (Juneda, les Garrigues); 9. Ilerda i Medina Larida (Lleida, el Segrià); 10. Roques del Sarró (Torres de Segre, el Segrià); 11. El Vilot de Montagut (Alcarràs, el Segrià); 12. Tossal de Solibernat (Torres de Segre, el Segrià); 13. Genó (Seròs, el Segrià); 14. Cova de Punta Farisa (Alcolea de Cinca, Osca); 15. Masada de Ratón (Candasnos, Osca); 16. Tozal de los Regallos (Candasnos, Huesca); 17. Vincamet (Fraga, Osca); 18. La Codera (Alcolea de Cinca, Osca).

Figure 1. Map of the North East of the Iberian Peninsula. Location of the 18 archaeological sites under study (Drawn up by Jordi Martínez).

the results. Nevertheless, one should keep in mind that the strength of this work lies in the large number of fragments and samples that can correct at least some of these limitations and provide a good overview of the whole.

In order to homogenize the sample a common database was elaborated. In this the nomenclature of various taxa was unified. One reason was to simplify the comparative work. However, we also took into account that is not possible to arrive at certain levels of identification in the case of some species due to the anatomical similarities among them.

The data processing focused, on the one hand, in the analysis of diversity (number of consumed taxa), the analysis of ubiquity (recurrence of use from the number of stratigraphic units in which the use of a taxon is documented) and the analysis of intensity of uses (from the number of remains, or frequencies per taxa). On the other hand, continuity and change in the most representative taxa were evaluated. We considered as representative taxa those that provided more than four hundred pieces of charcoal. The objective was to determine the woods with economic value for each period and evaluate the causes of the differences observed through time.

With the obtained results, we can see that the forested landscape of the western Catalan plain from the Neolithic to the Middle Ages presents a shifting panorama, always directly related to its social management.

With the adoption of agriculture from the Neolithic/Chalcolithic periods, increasingly effective tools (stone axes, adzes, etc.) that allowed more sophisticated logging activities were made. Due to the lack of data from previous periods we cannot affirm that those activities affected the vegetation cover. Still, we can document the most important taxa in the economic sphere. The best represented taxa and the ones that show a higher ubiquity are deciduous *Quercus* (oak) and evergreen *Quercus* (holm oak). This period is represented by two sites, Auvelles (Castelló de Farfanya, la Noguera) and Roques del Sarró (Torres de Segre, Segrià). The differences between the results are considerable. In Auvelles the predominant taxa are deciduous *Quercus* (oak) and evergreen *Quercus* (holm-oak). In contrast, at the Roques del Sarró, deciduous *Quercus* is not represented, whereas *Pistacia lentiscus* (mastic) has certain relevance. With regard to the taxonomic diversity observed among the deposits of this period the most remarkable is the low number of determined taxa, only 11 taxa for the entire period. Although evergreen *Quercus* is represented at both sites, the results show a different landscape during the Neolithic/Chalcolithic in the regions of Noguera (Auvelles) and Segrià (Roques del Sarró). In the northernmost region (La Noguera) fuel was collected in mixed forests of oaks. In contrast at Segrià, located further south, firewood was collected in more open formations, in which shrubland and bushland may have already had some importance.

In the following period (Early Bronze Age, 2700-1650 cal BC), with the emergence of large and scattered villages, the use of a different landscape is documented. This period is represented by a single site, Minferri (Juneda, Garrigues). Both evergreen and deciduous *Quercus* become secondary (Table 1) while *Pinus halepensis* (Aleppo pine) is the dominant taxon, followed by a shrub, *Arbutus unedo* (strawberry tree). This difference from the previous period could be due to the location of the site, much further south than the previous ones. However, we cannot exclude the possibility that a more open landscape had already begun to consolidate around the settlement.

The presence of shrubs is interpreted as a clear sign of the phenomenon of deforestation. However, the shrubs are important in the maquis, which nowadays occupies part of the Mediterranean coastal and interior lowlands. Continental maquis was probably extensive in the territory already during the time of the occupation of Minferri. The taxonomic diversity in the charcoal assemblages is greater than in the previous period. The consumption of a minimum of 23 taxa was determined. However we should remember that the number of fragments and contexts analyzed for this period is higher than for the Neolithic/Chalcolithic.

The vegetation represented in Minferri suggests high population pressure on the environment at the time of the occupation. Greater continuity of the settlement and its bigger size may have had an impact on the environment, forcing the collection of all types of wood, both of trees and shrubs or bushes.

The importance of taxa is similar comparing the number of represented taxa either by ubiquity or amount of remains (Table 1). The taxa follow the same order of importance: *Pinus halepensis*, *Arbutus unedo*, evergreen *Quercus* and *Pistacia lentiscus*.

The population of the Early Bronze Age constituted the elementary substrate on which, in the middle of the 2nd millennium BC, the emergence of new cultural, economic, and social attitudes that characterize the Segre-Cinca Group (GSC) (1650-1250 to 1000-800/750 cal BC) took place. In this period three phases can be distinguished: GSC I (1650-1250 cal BC), GSC II (1250-1000 cal BC) and GSC III (1000-800/750 cal BC) (Alonso *et al*. 1999). Among them there are differences in the exploitation of forest resources (Tables 2 and 3).

In the Segre-Cinca Group I, the species with a higher presence are *Pinus halepensis* and *Pistacia lentiscus*. Most fragments of *Pistacia lentiscus* come from Masada de Raton (Cadasnos, Huesca) and Cueva Punta Farisa (Alcolea de Cinca, Fraga) (Table 2). By contrast *Pinus halepensis* is especially important in Vilot 0 (Alfarràs, Segrià), Masada de Raton, and especially Genó (Seròs, Segrià). The ubiquity of the two species is high in all the archaeological sites. *Pistacia lentiscus* is represented in 64.15% of the samples, whereas *Pinus halepensis* appears in 86.79% of them. Depending on the number of remains the differences between these taxa are reduced (Table 2). Evergreen *Quercus* has a considerable reduction in both the number of fragments as in its ubiquity in relation to the previous period; it is represented only in Genó and, in smaller amounts, in the Roques del Sarró and Vilot 0. Population increase and stronger pressure

	NEOLITHIC/CHALCOLITHIC					EARLY BRONZE AGE		
	Auvelles (Martín i Piqué 2008)	Roques del Sarró (Equip Sarró 2000)	Total			Minferri (Piqué i Mensua 2001)		
Number of samples	49	3				155		
Taxa	Number of fragments		N	%	Ubiq	N	%	Ubiq
Acer sp.	3		3	0,16	1,92	1	0,05	0,65
Alnus sp.						1	0,05	0,65
Arbutus unedo						333	13,22	27,10
Atriplex halimus		4	4	0,21	1,92			
Berberis sp.						1	0,05	0,65
Cistus sp.						14	0,73	4,52
Deciduous *Quercus*	999		999	53,54	28,85	108	5,60	16,77
Erica sp.						1	0,05	0,65
Evergreen *Quercus*	679	12	691	37,03	59,62	276	14,30	35,48
Fabaceae	67		67	3,59	5,77	37	1,92	9,03
Fraxinus sp.	1		1	0,05	1,92	15	0,78	0,65
Globularia						2	0,10	0,65
Lonicera sp.						16	0,83	3,87
Monocotyledoneae						3	0,16	1,29
Olea europaea						2	0,10	0,65
Pinus halepensis	6		6	0,32	1,92	507	26,28	49,03
Pinus sp.						49	2,54	9,03
Pinus type *sylvestris/nigra*	5		5	0,27	1,92	13	0,67	1,94
Pistacia lentiscus		62	62	3,32	5,77	323	16,74	36,13
Pomoideae						13	0,67	3,23
Prunus sp.						73	3,78	5,81
Quercus sp.						18	0,93	4,52
Rhamnus Phillyrea						90	4,66	20,65
Rosmarinus officinalis		25	25	1,34	1,92	22	1,14	7,10
Tamarix sp.		3	3	0,16	1,92	5	0,25	1,94
Ulmus sp.						6	0,31	1,29
Indeterminable	14	1	15	-	-	896	-	-
Indeterminate		2	2	-	-	192	-	-
Cortex				-	-	80	-	-
Heart				-	-	2	-	-
Node				-	-	148	-	-
Total fragments analyzed	1774	109	1883	-	-	3247	-	-
Total fragments identified	1760	106	1866	-	-	1929	-	-

Table 1. Anthracological results in the western Catalan plain from the Neolithic/ Chalcolithic to the Early Bronze Age.

on the environment would have probably resulted in deforestation that could have been the cause of the changes observed in the consumption of plant fuel.

In Segre-Cinca Group II, *Pinus halepensis* stands out compared to the other species. This is the case mainly in Tossal de Solibernat (Torres de Segre, Segrià) (535 fragments) and secondly in Vincamet I (Fraga, Huesca) (189 fragments) (Table 3). With regard to ubiquity and number of fragments a similar hierarchy in species is evident; the main species are *Pinus halepensis, Pistacia lentiscus* and *Rosmarinus officinalis* (rosemary).

The Segre-Cinca Group III is represented by two sites: Vincamet (Vincamet phase I) and Vilot de Montagut (Vilot phases I and II). However 96.5% of the identified fragments come from Vilot de Montagut. For the first time, the taxon with the largest number of fragments is a shrub, *Pistacia lentiscus* (Table 3),

	SEGRE-CINCA GROUP I							
	C. Punta Farisa (Ros 1993)	El Vilot 0 (Alonso *et al.* 2002)	Genó (Ros 1994/1996; Maya et al. 1998)	M. Ratón (Ros 1995)	Roques Sarró (Equip Sarró 2000)	Total		
Number of samples	1	1	18	32	1			
Taxa	Number of fragments					N	%	Ubiq.
Acer sp.				2		2	0,13	3,77
Alnus sp.	2	9				11	0,71	3,77
Cistaceae	3	2		12		17	1,10	16,98
Deciduous *Quercus*			31			31	2,01	3,77
Evergreen *Quercus*	10	8	39	56	15	128	8,31	47,17
Fabaceae	11			49		60	3,89	39,62
Fraxinus sp.				2	5	7	0,45	5,66
Juniperus sp.	1	1			1	3	0,19	5,66
Pinus halepensis	41	127	394	136		698	45,30	86,79
Pistacia lentiscus	95	11		190	7	303	19,66	64,15
Pomoideae					1	1	0,06	1,89
Populus sp.	14		32	31		77	5,00	30,19
Quercus cf. *faginea*					2	2	0,13	1,89
Rhamnus/Phillyrea	5			22		27	1,75	24,53
Rosaceae				2		2	0,13	1,89
Rosmarinus officinalis	9	1		85		95	6,16	45,28
Salix sp.		4		16		20	1,30	13,21
Tamarix sp.	11			40		51	0,39	28,30
Ulmus sp.					6	6	3,31	1,89
Indeterminable		4		21	2	27	-	-
Indeterminate	2			17		19	-	-
Total fragments analyzed	204	167	496	681	39	1587	-	-
Total fragments identified	202	163	496	643	37	1541	-	-

Table 2. Anthracological results in the western Catalan plain during the Segre-Cinca Group I.

	SEGRE-CINCA GROUP II					SEGRE-CINCA GROUP III				
	T. Solibernat (Ros 1994/1996)	Vincamet I (Piqué 2003)	Total			Vilot I i II (Alonso *et al.* 2002)	Vincamet II (Piqué 2003)	Total		
Number of samples	1	7				14	4			
Taxa	Number of fragments		N	%	Ubiq.	Number of fragments		N	%	Ubiq.
Acer sp.	1		1	0,10	12,50					
Alnus sp.	7		7	0,72	12,50	13		13	2,84	22,22
Chenopodiaceae						1		1	0,22	5,56
Cistaceae						19		19	4,16	33,33
Deciduous *Quercus*						1		1	0,22	5,56
Evergreen *Quercus*	19	8	27	2,76	37,50	92		92	20,13	66,67
Fabaceae	5	9	14	1,43	25,00					
Fraxinus sp.	2		2	0,20	12,50					
Juniperus sp.	6		6	0,61	12,50	2	9	11	2,41	11,11
Monocotyledoneae		1	1	0,10	12,50					
Pinus halepensis	535	189	724	74,03	75,00	86		86	18,82	61,11
Pistacia lentiscus	48	6	54	5,52	25,00	122		122	26,70	72,22
Populus sp.	19	9	28	2,86	25,00	1		1	0,22	5,56
Prunus sp.						3		3	0,66	11,11
Rhamnus/Phillyrea	2		2	0,20	12,50	2		2	0,44	11,11
Rosaceae/Maloideae						5		5	1,09	11,11
Rosmarinus officinalis	20	23	43	4,40	50,00	84		84	18,38	61,11
Salix sp.	26		26	2,66	12,50	7		7	1,53	27,78
Tamarix sp.		41	41	4,19	37,50	3	7	10	2,19	22,22
Vitis vinifera	2		2	0,20	12,50					
Indeterminable	5	6	11	-	-	106	3	109	-	-
Indeterminate	3	2	5	-	-		1	1	-	-
Total fragments analyzed	700	294	994	-	-	547	20	567	-	-
Total fragments identified	692	286	978	-	-	441	16	457	-	-

Table 3. Anthracological results in the western Catalan plain during the Segre-Cinca Group II and Segre-Cinca Group III.

followed by two trees *Pinus halepensis* and evergreen *Quercus* that already had a significant presence during earlier periods. Also highlighted is the importance of a small shrub, *Rosmarinus officinalis*. The presence

	FIRST IRON AGE						
	El Vilot III (Alonso *et al.* 2002)	Els Vilars 0 i I (Ros 1995c)	La Codera (Piqué 2008)	T. Regallos (Ros 1995b)	Total		
Number of samples	1	17	34	14			
Taxa	Number of fragments				N	%	Ubiq
Alnus sp.	2				2	0,16	1,52
Arbutus unedo		6			6	0,49	4,55
Chenopodiaceae			1		1	0,08	1,52
Cistaceae	3	5	1	1	10	0,82	9,09
Ephedra sp.				2	2	0,16	1,52
Deciduous *Quercus*	2	65			67	5,49	15,15
Erica sp.		3			3	0,25	3,03
Evergreen *Quercus*	19	84	6	98	207	16,95	24,24
Fabaceae	1	3	2		6	0,49	1,52
Juniperus sp.	1				1	0,08	1,52
Labiatae				1	1	0,08	1,52
Pinus halepensis	47	10	28	499	584	47,83	43,94
Pinus type *sylvestris/nigra*	2	6	2		10	0,82	7,58
Pistacia lentiscus	22	49	16		87	7,13	27,27
Populus sp.			1	27	28	2,29	4,55
Prunus sp.	1				1	0,08	1,52
Rhamnus Phillyrea	1	3	7		11	0,90	4,55
Rosaceae/Maloideae	3				3	0,25	1,52
Rosmarinus officinalis	12	23	50	17	102	8,35	36,36
Salix sp.			13		13	1,06	7,58
Tamarix sp.		3	72		75	6,14	24,24
Ulmus sp.	1				1	0,08	1,52
Indeterminable	32	7	11		50	-	-
Indeterminate		4		2	6	-	-
Total fragments analyzed	149	271	210	647	1277	-	-
Total fragments identified	117	260	199	645	1221	-	-

Table 4. Anthracological results in the western Catalan plain during the First Iron Age.

	IBERIAN PERIOD						
	Estinclells (Allué i Euba 2005; Martín i Piqué 2009)	Els Vilars II i III (Ros 1995c)	Missatges (Piqué i Mensua 2001)	Roques del Sarró (Equip Sarró 2000)	Total		
Number of samples	23	18	34	13			
Taxa	Number of fragments				N	%	Ubiq
Acer sp.	1	1	8		10	0,58	8,57
Alnus sp.				23	23	1,34	5,68
Angiospermae	1				1	0,06	1,14
Arbutus unedo	1	7	2		10	0,58	6,82
Buxus sempervirens			27		27	1,57	4,55
Cistaceae		4		1	5	0,29	5,68
Coniferae			2		2	0,12	1,14
Deciduous *Quercus*	479	94	376		949	55,34	61,36
Erica sp.		5			5	0,29	3,41
Evergreen *Quercus*	54	153	9	9	225	13,12	30,68
Fabaceae		2		1	3	0,17	6,82
Ficus carica	2		3		5	0,29	3,41
Fraxinus sp.				34	34	1,98	1,14
Juniperus sp.			1	3	4	0,23	7,95
Pinus halepensis		20		11	31	1,81	4,55
Pinus type *sylvestres/nigra*	1	11	22	30	64	3,73	14,77
Pistacia lentiscus		19		9	28	1,63	10,23
Pomoideae			6	4	10	0,58	9,09
Populus sp.			3	12	15	0,87	6,82
Quercus cf. *faginea*				23	23	1,34	1,14
Rhamnus/Phillyrea				1	1	0,06	4,55
Rosaceae		1			1	0,06	1,14
Rosaceae/Maloideae	1	11			12	0,70	2,27
Rosmarinus officinalis		4	2	6	12	0,70	12,50
Salicaceae	14				14	0,82	1,14
Salix sp.			4	12	16	0,93	3,41
Tamarix sp.	1	3	10		14	0,82	4,55
Tilia sp.			3		3	0,17	1,14
Ulmus sp.	42		66	60	168	9,80	26,14
Vitis vinifera				1	1	0,06	1,14
Indeterminable	4	9	49	9	71	-	-
Indeterminate		8		2	10	-	-
Cortex	2				2	-	-
Total fragments analyzed	603	352	593	251	1799	-	-
Total fragments identified	597	335	544	240	1716	-	-

Table 5. Anthracological results in the western Catalan plain during the Iberian period.

of evergreen *Quercus* increases in relation to the previous period. This may be due to a recovery of the vegetation compared with the GSC II. However, we cannot exclude other possible explanations such as the enlargement of the catchment areas to remote parts in which *Quercus* still had a significant presence and which could have been exploited together with areas around the settlements.

The results for the First Iron Age (800/750-550 cal BC) show certain differences in relation of the GSC III. The best represented species is *Pinus halepensis*, whereas the consumption of *Pistacia lentiscus* that dominated the GSC III assemblage decreases (Table 4). Evergreen *Quercus* and *Rosmarinus officinalis* still have some relevance. The results show that the collection of firewood was carried out in a similar landscape at Tozal de los Regallos, Fortaleza dels Vilars (phases Vilars 0 and Vilars I) and Vilot de Montagut (phase Vilot III), where there was constant presence of *Pinus halepensis*, *Pistacia lentiscus* and evergreen *Quercus*. However, at the site of La Codera (Alcolea de Cinca, Baix Cinca) two shrubs are the predominant taxa: *Tamarix* sp. and *Rosmarinus officinalis*, both in terms of ubiquity and number of remains.

In the Iberian period (550-100 cal BC) forest exploitation in the plain experienced certain changes with respect to the previous period (Table 5). On the one hand, the assemblage shows an increase in the number of consumed taxa; now there are 28 taxa documented, while during the first Iron Age at least 22 were consumed. Another notable change is the considerable increase of deciduous *Quercus*, which together with evergreen *Quercus* are the best represented taxa, both in number of fragments as well as ubiquity. This greater taxonomic diversity and change in the consumed taxa could be the result of a change in catchment areas due to a progressive depletion of forest resources around settlements.

We should also note the growing importance of *Ulmus* sp. (elm), mainly characteristic of riparian woodland, and *Pinus* type *sylvestris/nigra* (pine) that at the present grows in mountainous areas. The presence of these taxa suggests a greater pressure on catchment areas that before were less exploited.

The landscape represented in the sites studied for this period shows some differences. In Estinclells (Verdú, Urgell), Missatges (Tàrrega, Urgell) and Fortalesa dels Vilars the best represented taxa, in both the number of fragments and ubiquity, are deciduous and evergreen *Quercus*. However, at other sites the relative importance of small riparian trees or shrubs is highlighted. This is the case of *Ulmus* sp. which is well represented in Estinclells, Missatges and Roques del Sarró.

During the Roman period, represented by the sites Iesso (Guissona, Segarra) and Ilerda (Lleida, Segrià), the number of consumed taxa increases considerably compared to the previous period (34). For the first time, the exploitation of the wood of fruit trees is observed in the record, which probably reflects the use of pruned branches as firewood. Among others, remains of *Vitis vinifera* (grapevine), *Olea europaea* (olive) and *Prunus* sp. (Table 6) are represented.

In this period shrubs and small trees such as *Ulmus* sp., *Tamarix* sp., *Rosmarinus officinalis*, *Fraxinus* sp. and *Pistacia lentiscus* among others would have been intensively exploited. However the tree taxa are the best represented. The dominant ones are *Pinus halepensis*, *Pinus* type *sylvestris*/*nigra*, deciduous and evergreen *Quercus*. Also remarkable is the presence of *Populus* sp. The Romanization in the western Catalan plain resulted in a significant intensification of the exploitation of arboreal taxa, although there was intensive use of all types of woody resources.

By the Middle Ages, which corresponds to the Islamic occupation, only 24 samples from three sites were analyzed, Medina Larida (Lleida, Segrià), Pla d'Almatà (Balaguer, Noguera) and Molí del Codina (Tarrega, Urgell). However, the large number of represented taxa (31 species) is remarkable (Table 6).

Pinus halepensis is the best represented taxon; however most of the remains come from Medina Larida (645 fragments of 794 in total). The following taxa in importance, depending on the number of remains

	ROMAN PERIOD					MIDDLE AGES/ISLAMIC PERIOD					
	Iesso (Buxó *et al.* 2004)	Ilerda (Piqué 1998a, 1998b; Piqué i Noguera 2000)	Total			Med. Larida (Piqué 1998b)	Molí Codina (Piqué 2006)	Pla D'Almatà (Piqué i Vila 2010)	Total		
Number of samples	7	31				12	1	11			
Taxa	Number of fragments		N	%	Ubiq	Number of fragments			N	%	Ubiq
Abies alba	1		1	0,04	2,63						
Acer sp.	2	13	15	0,67	13,16			3	3	0,38	12,50
Alnus sp.		10	10	0,44	10,53	1			1	0,13	4,17
Arbutus unedo		2	2	0,09	2,63			1	1	0,13	4,17
Betula sp.	21		21	0,93	5,26						
Buxus sempervirens	6	3	9	0,40	13,16			3	3	0,38	8,33
Celtis australis		31	31	1,38	10,53	1			1	0,13	4,17
cf. *Celtis* sp.						1			1	0,13	4,17
Chenopodiaceae		1	1	0,04	2,63						
Chenopodiaceae cf. *salsola*		181	181	8,05	2,63						
Cistus sp.						8			8	1,01	8,33
Corylus avellana	1		1	0,04	2,63						
cf. *Punica granatum*		3	3	0,13	5,26						
Deciduous *Quercus*	141	121	262	11,65	47,37	18	1	10	29	3,65	41,67
Erica sp.								3	3	0,38	8,33
Evergreen *Quercus*	8	136	144	6,41	50,00	65	1	48	114	14,36	62,50
Fabaceae	13	18	31	1,38	10,53	3			3	0,38	8,33
Fagus sp.		1	1	0,04	2,63						
Ficus carica	2	15	17	0,76	10,53	10		1	11	1,39	12,50
Fraxinus sp.	30	2	32	1,42	13,16		1		1	0,13	4,17
Juglans sp.		31	31	1,38	13,16	3	1	4	8	1,01	16,67
Juniperus sp.	1	2	3	0,13	5,26	3	1	2	6	0,76	16,67
Monocotyledoniae						2		5	7	0,88	8,33
Olea europaea		10	10	0,44	10,53	10			10	1,26	33,33
Pinus halepensis	5	399	404	17,97	47,37	258		3	261	32,87	37,50
Pinus sp.		6	6	0,27	7,89	4			4	0,50	4,17
Pinus type *sylvestris/nigra*	118	551	669	29,76	71,05	89	1	15	105	13,22	50,00
Pistacia lentiscus		52	52	2,31	28,95	54			54	6,80	12,50
Pomoideae	3		3	0,13	5,26	11		5	16	2,02	20,83
Populus sp.	4	100	104	4,63	7,89	4	1		5	0,63	8,33
Prunus sp.	1	27	28	1,25	23,68	15	1	23	39	4,91	45,83
Prunus dulcis						3			3	0,38	4,17
Pyrus malus		1	1	0,04	2,63	14			14	1,76	16,67
Rhamnus/Phillyrea		8	8	0,36	10,53	3		2	5	0,63	16,67
Rosaceae/Maloideae		41	41	1,82	13,16	1			1	0,13	4,17
Rosoideae	2		2	0,09	5,26						
Rosmarinus officinalis		59	59	2,62	21,05	2		2	4	0,50	12,50
Salix sp.	6	20	26	1,16	21,05	13		3	16	2,02	16,67
Sorbus sp.						10			10	1,26	16,67
Tamarix sp.		3	3	0,13	7,89	38			38	4,79	33,33
Ulmus sp.	2	31	33	1,47	18,42	1			1	0,13	4,17
Vitis vinifera		3	3	0,13	5,26		1	7	8	1,01	16,67
Indeterminable	3	158	161	-	-	9		5	14	-	-
Indeterminate		32	32	-	-	43			43	-	-
Node		8	8	-	-			4	4	-	-
Cortex		2	2	-	-			1	1	-	-
Total fragments analyzed	370	2081	2451	-	-	697	9	152	858	-	-
Total fragments identified	367	1881	2248	-	-	645	9	140	794	-	-

Table 6. Anthracological results in the western Catalan plain during the Roman period and the Middle Ages/ Islamic period.

are evergreen *Quercus* and *Prunus* sp. Furthermore, *Pinus* type *sylvestris/nigra* maintains a high ubiquity in this period.

DISCUSSION

The data obtained show certain continuity in the landscape exploited throughout the period, while we can also observe remarkable differences in the modalities of utilization of resources (Fig. 2).

Except for the Neolitic/Chalcolithic sites, where deciduous *Quercus* and evergreen *Quercus* predominate, the most important aspect of all other periods is the continuity in relation to the species used. From the Early Bronze Age until the Middle Ages *Pinus halepensis* played a major role. Along with it, *Pistacia lentiscus*, *Rosmarinus officinalis* and both *Quercus* (deciduous and evergreen) were constantly present. Their presence together with other taxa as *Cistaceae*, *Rhamnus/Phillyrea* and *Fabaceae*, seems to indicate an open landscape. This open landscape could have been the result of pressure on the environment by the people of the Early Bronze Age (2700-1650 cal BC) and later periods. However, we must also take into account that the continental maquis, now dominant in the area, is characterized by the importance of shrub and its association with *Pinus halepensis*. Therefore, we cannot discard that maquis was already widespread in the area since the Bronze Age. This maquis type landscape was intensively exploited for obtaining fuel. Its

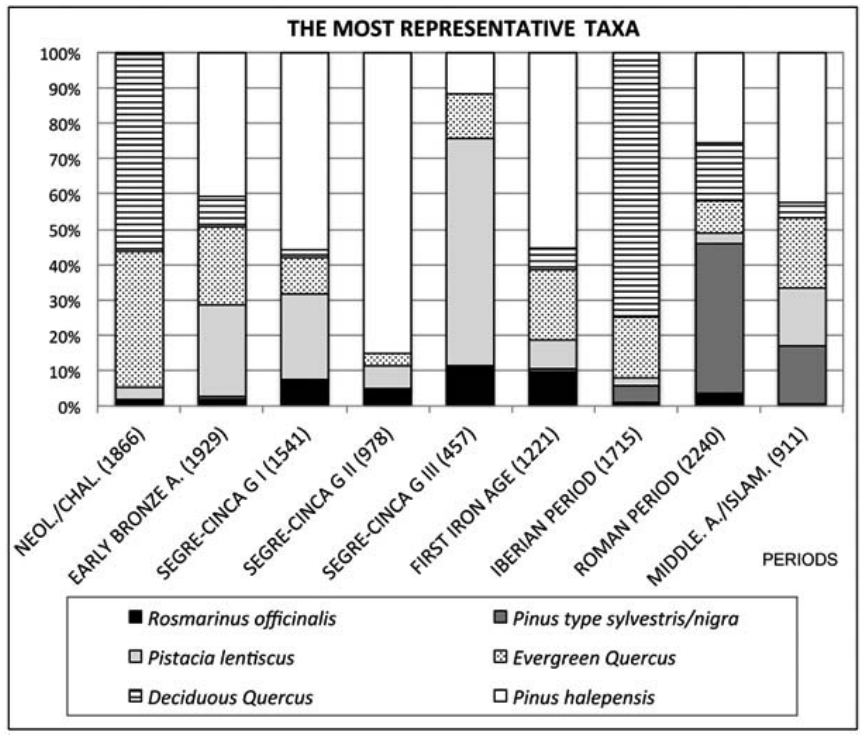


Figure 2. Main taxa from the Neolithic/Chalcolithic to the Middle Ages in the western Catalan plain (in parentheses beside the name of every period, the number of remains is shown).

presence is especially notable during the Segre-Cinca Group and the First Iron Age. In general, since the Early Bronze Age maquis vegetation could have constituted an important source of woody resources for the procurement of fuel.

However, the presence of *Pinus halepensis* fluctuates over time; for example it decreases in the Iberian period, when it is no longer the best represented taxon due to the greater importance of deciduous *Quercus* and *Pinus* type *sylvestris-nigra*. These taxa continue being important in Roman times. We believe that the data reflects the expansion of the catchment areas, probably due to the reduced availability of wood resources in the immediate vicinity of the settlements. It should be kept in mind that, since the Early Bronze Age, the western Catalan plain was occupied by people living in permanent settlements. During the Bronze Age the emergence of large villages with a scattered pattern occured, while in the Segre-Cinca Group a stable settlement pattern linked to stone architecture was intensified. Undoubtedly, continued occupation and proto-urban characteristics would have had significant consequences on the vegetation structure.

Among the most notable differences a highlight is the increasing number of consumed taxa from the Neolithic/Chalcolithic period to the Middle Ages/Islamic period. This increase in the richness of taxa could have been the result of increasing pressure on the environment, which would have resulted in the need to take advantage of every available woody resource for firewood. In this sense, riparian vegetation was especially exploited since the occupation of the Segre-Cinca Group. We also believe that the increased presence of deciduous *Quercus* since Iberian times and *Pinus* type *sylvestris-nigra* during the Roman period could have been the result of the expansion of the catchment areas to middle altitudes, a little further from the flat area where the settlements were located.

CONCLUSIONS

The forest landscape of the plains, from the Neolithic/Chalcolithic to the Middle Ages/Islamic period, presents a changing panorama. During the Neolithic/

Chalcolithic the best represented taxa, both in terms of relative frequency and ubiquity, are deciduous and evergreen *Quercus*.

During the Early Bronze Age (2700-1650 cal BC), with the appearance of large settlements in a scattered pattern, the landscape was different to the above, now dominated by Mediterranean species such as *Pinus halepensis* and evergreen *Quercus*, *Arbutus unedo* and *Pistacia lentiscus*. The presence of shrubs has generally been interpreted as a clear signal of deforestation. However, shrubs are important in maquis type formations, which currently occupy part of the Mediterranean coastal lowlands and interior.

During the Segre-Cinca Group I (1650-1250 cal BC) a stable population associated with stone architecture increased. The predominant species during that period were *Pinus halepensis, Pistacia lentiscus*, and *Rosmarinus officinalis*. During the Segre-Cinca Group II (1250-1000 cal BC) there were no major changes. However, during the Segre-Cinca Group III (1000-800/750 cal. BC), an increase in the presence of evergreen *Quercus* is observed in coincidence with the beginning of a process of concentration of habitats.

During the Iberian period (550-100 cal BC) the use of evergreen and deciduous *Quercus* increased, to the detriment of *Pinus halepensis*. With the Romans the use of a large number of taxa intensified, among which were *Pinus* type *sylvestris*/*nigra*, *Pinus halepensis,* deciduous *Quercus*, evergreen *Quercus,* etc. These changes, in respect to the previous phase might be the result of the enlargement of the catchment areas. The decrease of woody resources in the immediate surroundings of the settlements could be one of the factors that would explain this change.

The vegetation of the western Catalan plain has a distinctly Mediterranean character during prehistoric and recent historic times, with the exception of the Neolithic. Throughout the phases studied degradation of the forest cover is evident. In this sense, we stress the importance of colonizer shrub species in practically all of the studied periods. Changes in the catchment areas represented in these periods could also be another indicator of the degradation. This would have led to the enlargement of the catchment areas to more distant lands, first riparian woodland and secondly forests at higher altitudes.

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